Space Weather Technical Forecast

Issued on Thursday, 22 December 2022 at 01:06 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares and G1/Minor Geomagnetic Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with occasional C-Class flares, the largest a C7.6 flare at 21/ 0621 UTC from previous region AR3166 which has now rotated onto the far side. Most remaining flares originated from AR3169, which is an elongated group in the northeast quadrant with a series of relatively small leader spots, but no penumbra now on the trailer spots. There is some magnetic complexity, with AR3169 currently classified as a Csi/Beta-gamma, which is further complicated by AR3171 (Csi/Beta-Gamma), which follows close behind AR3169 and also has some magnetic complexity. The split between these two regions is difficult to determine. AR3170 in the southeast has also had some C-flare activity, despite its simple classification of Bxi/beta and weak appearance. AR3163 (Dki/Beta), has a large leader spot with nearby reverse polarity spot emergence, but has seen fading of its trailing spots and it remains inactive so far. The remaining regions are all small, magnetically simple, weak and relatively stable.

A narrow CME occurred close to AR3169, associated with a C6.6 flare at 21/0519 UTC, which may give a glancing blow late on the 23rd. No other Earth directed CME's where observed.

Solar Wind / Geomagnetic Activity: Solar winds have been indicative of an early possible weak transient features passing Earth, likely due to glances from a CME, followed by a weak CIR ahead of a weak HSS from CH55+ or CH56. Solar wind speeds were at background to slightly elevated levels, peaking at 431 km/s at 21/1426 UTC. Density has generally been average, with a peak slightly above average of 12 ppcc at 21/2313 UTC. The total IMF, Bt, was Moderate for much of the day, peaking at 15nT around 21/0830 UTC, but later declined to end the day at weak levels. The Bz oscillated between southward and northward, varying between +11 and -11 nT. The phi angle was initially negative (towards the Sun), but changed later in the period to become positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, was at Background levels to occasionally Moderate levels, peaking at 139 pfu. The associated 24-hour fluence continued on a steady trend well below Active (1e8 integrated pfu). Observed fluence at 22/0001 UTC was 1.33e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with occasional C-flares and an ongoing chance of isolated M-flares. The most likely source is AR3163 in the southwest, or AR3169 in the northeast. These also bring a very slight chance of X-class flares.

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Met Office Space Weather Technical Forecast

Solar Wind / Geomagnetic Activity: A filament eruption occurred yesterday in the northeast quadrant, which may give a glancing blow late on the 23rd. No other Earth directed CME's where observed. Solar winds are forecast to be predominantly slightly elevated, and occasionally elevated, through the period due to the combination of High Speed Streams (HSS) from CH55/+ and then CH56/+.

Quiet to Unsettled geomagnetic activity at first, is expected to become Unsettled to Active today, with a chance of isolated G1/Minor Storm intervals. This chance decreases a little for most of tomorrow (23 Dec), before increasing slightly again later on the 23rd due to the potential glancing blow of a weak CME, which is then followed by a HSS from CH56 becoming geoeffective.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels throughout, although there is slight chance of this reaching the S1/Minor Storm level should any notable flares occur. High energy (greater than 2 MeV) electron flux as observed by GOES-16 is currently at background levels. An increase is possible later in the period due to expected fast winds from coronal hole features. The associated 24 hour electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold, despite an expected rising trend.

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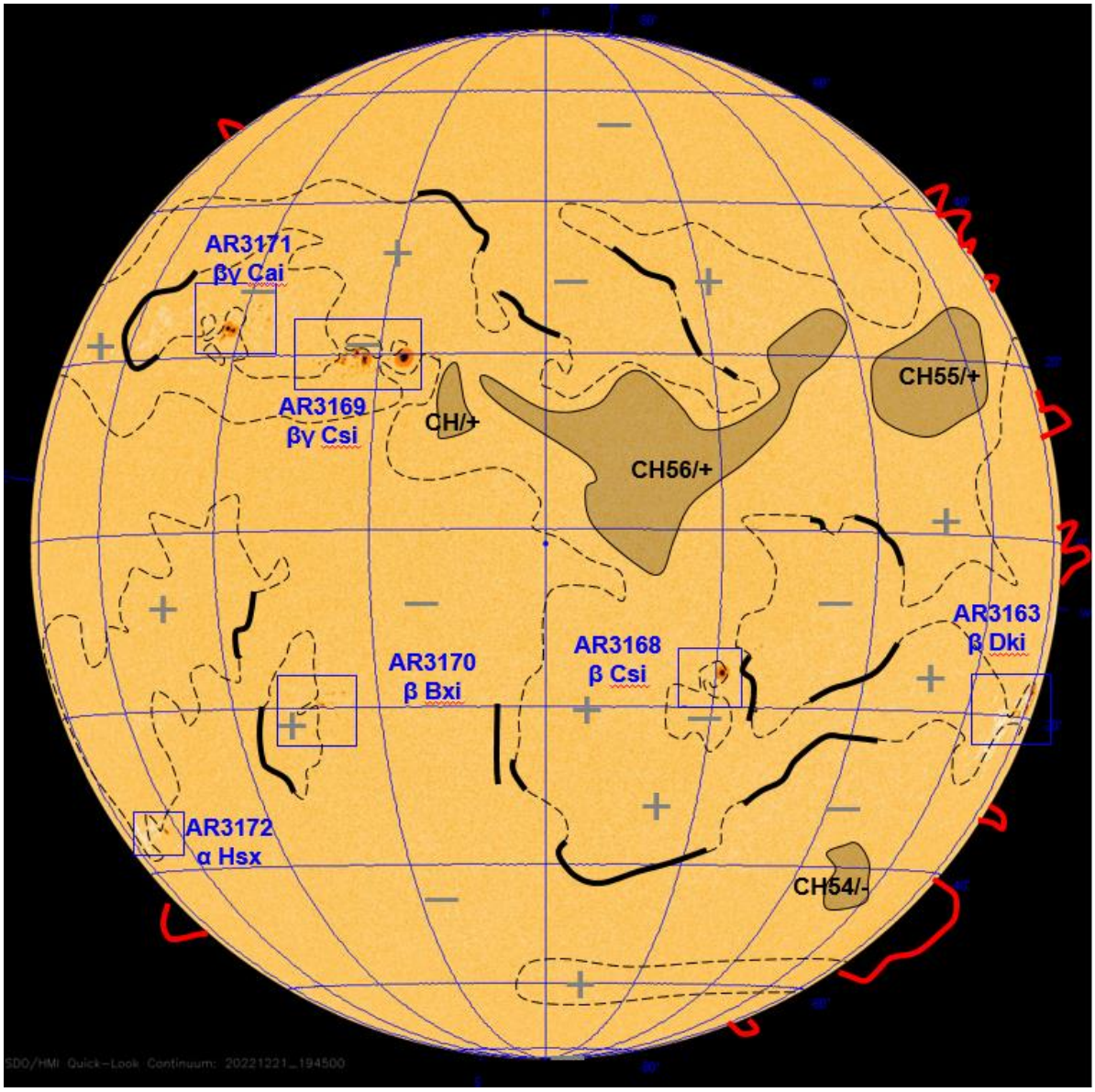
Figure 1. Solar Analysis Valid 21/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A narrow CME occurred near AR3169 associated with a C6.6 flare at 21/0519 UTC, which may give a glancing blow late on the 23rd. However, confidence is low regarding this. No other Earth directed CME's are expected.

Solar winds are forecast to be predominantly slightly elevated, and occasionally elevated, through the period due to the combination of High Speed Streams (HSS) from CH55/+ and then CH56/+. This is in broad agreement with MOSWOC Enlil and the 27-day persistence model, and also with data from STEREO-A data.

Quiet to Unsettled geomagnetic activity at first, is expected to become Unsettled to Active today, with a chance of isolated G1/Minor Storm intervals. This chance decreases a little for most of tomorrow (23 Dec), before increasing slightly again later in the day due to the potential glancing blow of a weak CME, which is then followed by a HSS from CH56 becoming geoeffective.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/1001	Partial	C6.6 flare	E limb	845	23/2000	Limited shock expected Low confidence

Figure 2: MOSWOC Enlil indicating potential CME arrival late tomorrow.

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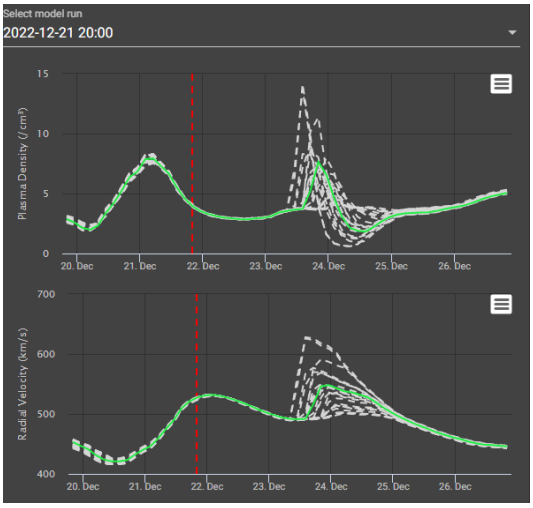
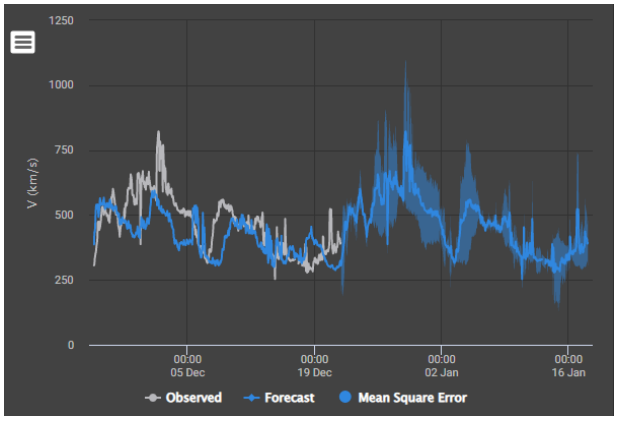


Figure 3: MOSWOC persistence model.



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Radio Blackouts - X-Ray Flares:

There are currently 6 sunspots regions on the visible disc, as AR3166 has now rotated onto the far side while the new region in the southeast has been numbered as AR3172. The largest regions on the disc remain AR3163 (Dki/Beta) and AR3169 (Csi/Beta-Gamma). Both these regions previously showed signs of decay of their trailing spots, but AR3163 is now approaching the southwest limb and so becoming harder to analyse and to determine any change. Meanwhile AR3169 appears to have slightly increased in penumbra area around some of the intermediate spots. AR3168 has developed small leading spots ahead of the main spot with penumbra, and is now a Csi/beta.The northeast quadrant remains complicated by the close proximity of AR3171 (Cai/Beta-Gamma) to AR3169 and it is difficult to determine the split between these two regions and thus their magnetic complexity.

Activity is expected to be Low with a chance of isolated M-flares and just a slight chance of X-flares, with Ar3169 the most likely region to produce significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is expected to remain at background levels. However, there is a slight chance of an enhancement reaching the S1 Minor Storm level, with a number of notable sunspots currently on the disc.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

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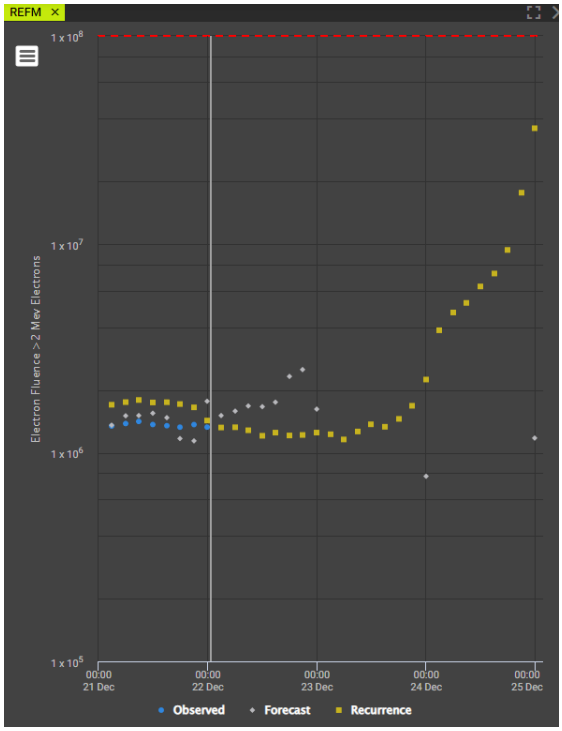
High energy (greater than 2 MeV) electron flux as observed by GOES-16 is currently at background to occasionally moderate levels. Enhancements in the solar wind from coronal hole features through the period have the potential to result in increased counts later in the period, most likely rising to Moderate, with a chance of a diurnal peak of High on from tomorrow (23 Dec) but more likely from day 3 (24th).

The associated 24 hour electron fluence is forecast to remain below the Active (1e8 integrated pfu) threshold, despite a rising trend, as indicated by REFM, which is currently considered to be giving good guidance. On the previous rotation which was similar in terms of coronal holes, the fluence rose on the equivalent of Day 3 but didn't quite reach Active for several more days. As such, fluence may rise later in the period, however this is low confidence and it is more likely fluence will stay below Active until next week.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Met Office REFM model.



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